Groundwater Resources Exploitation in China

Li Lierong,

1. Groundwater resources

It is estimated that there are 2800 billion m^3 water resources in china. It ranks 6^{th} in the world. Per capita water resources is 2100 m^3 /a, only 1/4 of the world mean figure, ranked 88^{th} for all the countries.

Groundwater resources make up about 30% of total water resources in china. It is also one of the major supply water sources, especially in northern china. The groundwater resources is 870 billion m^3 /a, of which, 290 billion m^3 /a is exploitable and 3/5 of that deposited in the big basins in northern china. The usable amount of water from big spring s and underground rivers is about 60 billion m^3 /a, mainly distributed in southwestern and middle-southern china. There are big karst springs in Shanxi and Shandong provinces which are important water-supply resources in the area. There are 174.817 billion m^3 /a exploitable groundwater resources in 17 provinces, in north china, of which , 128.402 billion m^3 /a is in plains.

2. Developing of groundwater

Groundwater has been widely developed in china, Amount of exploited has been steadily increasing during the last tow decades. At the end of 80s',exploited groundwater was 87.5 billion m^3 /a, by the end of 90s',it is 100 billion m^3 /a. Groundwater is important water sources in north china. It makes up 80-90% city consumed water and 38% of irrigation water. In some provinces, like Shanxi and Henan, irrigation water can be more than 50%, even more than 75% in Hebei province. Annual developed groundwater in northern china was 78.341 billion m^3 /a in 1994 with 3,187,400 water wells. 2,831,800 mu farmland was irrigated, it was 47.5% of total irrigable land. Intensity of groundwater developing varies with regions. There are 57 cities where groundwater was over developed, of which 37 are serious, and 136 cities still have developing potentiality. Potentiality of groundwater in northern china is 102.716 billion m^3 /a, but in particular places, there is 6.24 billion m^3 /a of groundwater over exploited.

Most places in north china have experienced serious groundwater over-exploiting. In Hebei province, over-exploiting rat reaches up to 126%, Beijing, 109.38%. Most regions, particularly in big and medium-size cities are more or less experienced groundwater exploited situation except to the Yellow River influencing area in Shandong province and the piedmont area of Yanshan Mts.

In northeast china, only in Liaoning province, groundwater is over-developed, the rate is 70%. Groundwater resources in Jilin and Heilongjiang provinces still have some potentiality.

Shiyanghe basin and Tuha basin etc are all over developed for groundwater. In Xuhuai region of Jiangsu Province and Anhui Province, the exploiting intensity of groundwater is relatively low, it is less than 20%.

3.Main problems with over exploiting groundwater

There are some places, like north china,Shandong province, northwest region, Liaozhongnan region and some coastal cities where fresh water supply-demand contradiction is prominent. there are 188 cities,0.8 billion mu farmland, and a billion mu grassland with water shortage problems, about 40 million people and 30 million livestock still remain unsolved completely for water problem. It is estimated that in middle 21th century, the total amount of water demand will be 800 billion m^3 /a, increase 300 billion m^3 /a, which will be about 28% of total water resources in china. At that time the water crisis may occur.

3.1 Unsuitable developing groundwater

In many regions, the groundwater can't be developed according to their natural characteristics, so cause some problems. There are mutual interrelations between waters from plain rivers and groundwater in northwest china, they form the river-aquifer systems, water utilization rate is very high (amount of reuse water is 26-43%). There the possible biggest amount of supply-water is total natural water resources plus recycle water. In history, those rivers formed ecological balance irrigation systems, i.e. irrigating regions with water from piedmont fluvial fans, irrigating regions with the water from springs in the spill-over area of fine-soil plains and regions from both of them. The balance pattern was broken as a result of exploited groundwater ignoring the geological conditions. For example, since 60s', the supplying amount of groundwater has been considerably reduced in Shiyanghe river basin due to reservoir construction and seepage prevention of channels. As result, the area with spring irrigating had to substituting by well irrigating, because no more springs exist. Previous irrigating area with springs and wells in the lower parts of fine-soil plain becomes the irrigating area with river water, well and springs. Since 1950s',developed groundwater has decreased from 1.3 billion m^3 /a to 0.9 billion m^3 /a (spring discharge from 0.8 billion m^3 /a to 0.4 billion m^3 /a), well yield increased from zero to 0.7 billion m^3 /a, the over-exploited amount is 0.5 billion m^3 /a. It causes groundwater level decrease 2—20 m. Such results lead to increasing groundwater salt content. 200,000 mu farmland become salified at the speed of 10—20 m each year. In the upper reach es of Talimu river, irrigation with large amount of river water lead the groundwater level raising by 1—3 m, the soil was salinfied. There is 3,700,000 mu farmland,46.6% of which has become secondary salinization and over 400,000 mu has been abandoned.

In Ningxia, Hetao plain, and Shandong Yellow river catchment irrigation regions, because

irrigating with Yellow river water is more easy than other water resources, so large amount of irrigating cause serious soil salinization.

In Hebei province, there were reservoir at each river leading to no water to the stream and river functions become deteriorated. As a result, groundwater can't play party in supplying water resources, soil desertification continuously worsen, whole plain became dried, so that, the vicious circle of ecological environment runs.

In Huanghuaihai plain, 14 drawdowns of groundwater level has formed, well yields decreases by 1/5,and soil lost 50% water content, the up aquifer water level drops at speed of 0.5-1.0 m/a. The water storage decreases 7 billion $m^{3.}$ Nearly 5,000 sq.km aquifer become dried. On the other hand, deep aquifer groundwater level drops by 30-50 m with the speed of 1.5-2 m/a, water storage decreases 7 billion m^3 , It is 34,000 sq.km of local land subsidence with accumulative 100-600 mm ,and 5,000 sq.km with 600-1,100 mm. Such over-exploited deep groundwater resulted in the increase of fluorine content and broaden the fluorine-affected area. There are land subsidence in 30 cities and couties,that more than 100 sits was founded. There are more than 100 land crackes in Luxibei plain, Huaibei plain, Hangjiahu basin. All those was caused by developing groundwater.

Ther are karst collapse in more than 10 places in Tangshan and Qinhuangdao, also in 400 karst caves .

3.2 groundwater resources waste

There is lot of water wasting in irrigation. About 140 billion m^3 /a is used for irrigation in north china. It is 80% of total used water. The traditional irrigation methods were remained in many regions with high gross irrigation quota of 400—600 m^3 /a. In northern china it even reaches 700-1000 m^3 /a. The efficient is only 30%, so cause the soil salinization.

Industry also wastes water resources too. The use water amount for unit production in china is 5—10 times that in developed countries. Reused rate for water in industry is 20—30%, far below the mean value in developed countries. 50 billion m^3 /a are used in cities,but wasted resource water accounts for 1/3 of total used water.

3.3 Groundwater pollution

According to the result of groundwater investigation, there are more than 80 big and medium-sized cities like Baotou,Changchun,Zhengzhou,etc, where the groundwater was polluted in various degrees. Some agricultural area near the cities are also polluted. There are 20 million mu lands that are irrigated with sewage water, which cause some groundwater pollution too.

4. The countermeasures of groundwater resources exploitation

For solving water problems in china is to reduce water waste and prevent water pollution and strengthen water resources management. To Resolve water supply-demand problem_one way is to prospect new water sources_other is to save the used water. The aim to establish economic society with saving water pattern. The total exploited groundwater in north china accounts for 45% of the exploitable resources_There is a large amount of groundwater resources stored in the deep and large geological conformation basins. It is difficulty to recharge it, but moderately developing these deep confined water can solve man and domestic animal's drinking water supply and part of industrial and agricultural water temporally. This is especially important in water shortage regions.

(1)※Principles for solving groundwater developing problem are as follows: to exploit jointly surface water and groundwater, make overall program and take all factors into consideration for whole river system_utilize synthetically shallow and deeper groundwater, dig fully potential possibilities, supply predominance each other, carry out scientific planing and reasonable overall arrangement.

(2)※Establish man-made groundwater regulating demonstrate engineering. Primarily analysis indicate that: A few of piedmont plains where exist underground water regulating capacity. It is estimated that there is more than 100 billion m^3 groundwater regulating potentiality in north china where water shortage is serious for the country. It is 1/4 of reservoir's overall capacity. Carrying out man-made groundwater regulating methods can utilize furthest water resources, improve agricultural environment, prevent soil erosion_reduce agricultural irrigation_hasten surface plan growth and improve biology variety. It is a very important strategic projects.

(3)※Hold "saving water" as a long-term prior policy. Carry it through every walk of life and every family.

(4)※For protecting source_we should make up our mind to prevent source from pollution _strictly execute national law and statute about environment protecting _carry out synthetically prevent and cure policy mad by local government.